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October 16, 2018

VIA ELECTRONIC FILING

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: WC Docket No. 17-287 - Bridging the Digital Divide for Low-Income Consumers
WC Docket No. 11-42 – Lifeline and Link Up Reform and Modernization
WC Docket No. 09-197 – Telecommunications Carriers Eligible for Universal Service Support
EX PARTE PRESENTATION

Dear Ms. Dortch:

This letter is submitted on behalf of TracFone Wireless, Inc. (TracFone). Enclosed with this letter is a report entitled "Competition in Wireless Telecommunications: The Role of MVNOs and Cable's Entry into Wireless." That report was authored by Michelle Connolly, Ph.D. Dr. Connolly is a former Chief Economist of the Commission. Although Dr. Connolly's report may be in the record of other pending Commission proceedings, TracFone respectfully requests that it be made part of the record in the above-captioned docketed proceedings in which the Commission is considering reforms to the Lifeline program supported by the federal Universal Service Fund. See also "Three Reasons to Heed Michelle Connolly on Wireless Competition," by Randolph May, Free State Foundation Blog, issued October 9, 2018.

Dr. Connolly's report is relevant to the ongoing Lifeline proceeding for two reasons. First, the report makes a persuasive case that Mobile Virtual Network Operators (MVNOs) are an integral part of the wireless services market, and their participation in that market should be considered by the Commission in assessing the competitiveness of that market. Dr. Connolly's recognition of the significance of MVNOs as wireless providers and participants in the competitive wireless marketplace is plainly inconsistent with the Commission's largely discredited, but still pending, proposal to unilaterally exclude MVNOs from participation in an important segment of the wireless market – the market for wireless Lifeline services.

Of greater importance, the Commission's attention is directed to page 9 of Dr. Connolly's report. There she states as follows: "Higher income households tend to have subscriptions to both fixed broadband and wireless telephony/broadband, while younger adults, non-whites, **and lower-income households** are more likely to *exclusively* use wireless telephony/broadband to connect to the internet." (emphasis added). In this important respect, Dr. Connolly's statement is correct. Lower-income households often rely exclusively on wireless services both for telephony and for broadband internet access. Many of those lower-income households are Lifeline-eligible and obtain their voice telephony and internet access service through the federal Lifeline program.

In 2016, the Commission, by a 3-2 vote (with Commissioners Pai and O'Rielly dissenting), established a series of minimum service standard regulations for Lifeline services. Those regulations are codified at Section 54.408 of the Commission's rules. They became effective December 2, 2016 and have been increased in each subsequent year. Many stakeholders, including TracFone and other Lifeline providers, have commented that these paternalistic minimum service standards, however well-intentioned they might have been at the time of their adoption, would have the perverse result of rendering Lifeline service unaffordable for many Lifeline-reliant households and would lead to reductions in program participation. In short, those constantly-increasing minimum service standards – the result of regulatory fiat – will actually cause harm to the very consumers (Lifeline-eligible low-income households) the program was intended to help.

The economic dislocation of many low-income households who rely on affordable telephony and broadband internet access through the Lifeline offerings of wireless Lifeline providers is similar to the economic dislocations faced by those low-income households who obtain their Lifeline services from rural wireline local exchange carriers. As NTCA – The Rural Broadband Association, noted in its petition for temporary waiver of the increased minimum speed requirements for fixed wireline broadband internet access, those mandatory speed increases will make broadband service unaffordable for many low-income households and will force those households to discontinue service. See Petition of Temporary Waiver of NTCA – The Rural Broadband Association filed in WC Docket Nos. 11-42, 09-197, and 10-90, July 23. 2018, at 2-3.

TracFone has explained that the annual increases to the Commission-mandated minimum service standards will require Lifeline providers to spend far more than the $9.25 monthly Lifeline subsidy in order to deliver services which meet those standards. The effect will be to force those providers to impose substantial monthly charges on their Lifeline customers – charges well in excess of what most Lifeline customers can afford to pay. Indeed, these regulator-mandated burdensome increases already have caused TracFone to limit and, in some cases, eliminate its longstanding practice of providing wireless devices to consumers out of the company's own resources. The economic infeasibility of continuing to provide at no charge wireless devices, including smartphones, to Lifeline consumers is particularly harmful. Notwithstanding the fact that device costs have never been supported by the Universal Service Fund, the cost of Internet access-capable smartphones remains a major impediment to making broadband Internet access affordable to low-income households. Dr. Connolly's conclusion regarding low-income households' reliance on wireless broadband service corroborates those concerns previously expressed by TracFone and others.

Dr. Connolly's report should serve as an important reminder to the Commission that the Lifeline minimum standards regulation promulgated by the prior Commission needs to be revisited or at least applied in a flexible manner such that Lifeline consumers, rather than the Commission, determine how best to use their Lifeline-supported services. One such flexible approach would be the "units" plan proposed by TracFone and put out for comment in the Commission's Lifeline

rulemaking notice.[1] Under that proposal, Lifeline consumers would receive a quantity of "units" each month. Those units could be used either for voice telephony or for broadband Internet access, depending on each consumer's needs and preferences. Although implementation of such a units plan could take some time, it would give consumers more control of their Lifeline services, would enable low-income households to avoid precipitous increases in minimum standards which would make Lifeline-supported services unaffordable to many, and would enable all low-income households to remain connected. As an alternative to the units proposal, TracFone reiterates its suggestion that the Commission freeze the minimum service standards at the December 1, 2017 levels (*i.e.*, 750 minutes of voice telephony or 1 GB of mobile broadband Internet access) pending the outcome of the forthcoming State of the Lifeline Marketplace Report.[2] Over time, voice telephony service (wireline and wireless) may be replaced by Internet Protocol-based applications. When that time arrives, it may no longer be necessary for the Lifeline program to subsidize traditional voice service. However, that time has not yet arrived, particularly for low-income Lifeline-eligible households who continue to rely on wireless voice telephony service as their exclusive means for communicating with family members, health care providers, employers, government services, and others – and for accessing emergency services such as E911. For those millions of Lifeline consumers, voice telephony service is indeed their "Lifeline" and its preservation and affordability remains of critical importance.

TracFone respectfully urges the Commission to be mindful of Dr. Connolly's concerns about low-income households' reliance on wireless service for telephony and internet access, and that it either adjust or interpret the minimum service standards in a manner which is responsive to those concerns. Those low-income households participating in the Lifeline program should not lose their access either to voice telephony or broadband internet access services as a result of well-intentioned, but unnecessary and burdensome minimum service standard regulations imposed by the prior commission which may place such services beyond the means of those households who most need support in order to obtain essential services which are affordable to them.

Pursuant to Section 1.1206(b) of the Commission's rules, this ex parte letter is being filed electronically. If there are questions, please communicate with undersigned counsel for TracFone.

Sincerely,

Mitchell F. Brecher

Enclosure

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[1] Bridging the Digital Divide for Low-Income Consumers, *et al* (*Fourth Report an Order, Order on Reconsideration, Memorandum Opinion and Order, Notice of Proposed Rulemaking, and Notice of Inquiry*), 32 FCC Rcd 10475, at ¶ 80.

[2] See, *e.g.*, Reply Comments of TracFone Wireless, Inc. WC Docket Nos. 17-287, 11-42, and 09-197, filed September 14, 2018.

cc: Mr Nicholas Degani
Jay Schwarz, Ph.D.
Ms. Arielle Roth
Ms. Jamie Susskind
Mr. Travis Litman
Mr. Ryan Palmer
Ms. Jodi Griffin

Enclosure

COMPETITION IN WIRELESS TELECOMMUNICATIONS:
The Role of MVNOs and Cable's Entry into Wireless

MICHELLE CONNOLLY, PH.D.
SEPTEMBER 2018

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01.

EXECUTIVE SUMMARY*

This report examines the competitive effects of Hybrid Mobile Network Operators (HMNOs)—mobile virtual network operators that rely in large part on self-deployed facilities—on the market for mobile wireless services and recommends that the Federal Communications Commission (FCC) broaden its now antiquated definition of the mobile telephony and broadband market to account for HMNOs. HMNOs share certain characteristics of both facilities-based carriers (Mobile Network Operators or MNOs) and non-facilities-based providers of mobile services (Mobile Virtual Network Operators or MVNOs). An understanding of MVNOs therefore partially illuminates the competitive impact of HMNOs, but HMNOs are poised to play a competitive role in the wireless marketplace that goes substantially beyond that of traditional MVNOs.

The FCC's current narrow definition of the wireless market, which includes only facilities-based MNOs, inaccurately reflects how the market is satisfying consumer demand for mobile broadband services. HMNOs—particularly cable operators that are offering mobile wireless services—are well positioned to compete aggressively in the wireless broadband market and have already begun to do so. In evaluating wireless marketplace transactions, including the proposed merger of Sprint and T-Mobile, the FCC should consider the competitive effects of HMNOs.

* This report has been underwritten by T-Mobile. Any opinions expressed in this report are those of the author alone.

• HMNOs use a combination of facilities to provide wireless service and are not as reliant on MNOs as are pure MVNOs. Cable operator HMNOs own high-capacity network facilities that enable them to offload a majority of the voice and data traffic coming from mobile devices onto their fixed broadband networks. For example, rather than relying solely on their MVNO agreements to use Verizon's mobile network, Comcast and Charter Communications use their own extensive Wi-Fi hotspot networks to deliver wireless service to their customers over wide geographic areas. Comcast and Charter thus are providing wireless service using a hybrid strategy, combining a traditional non-facilities-based MVNO agreements and facilities-based MNOs.

• HMNOs have launched successfully and are growing rapidly. Comcast's mobile service is currently only available to customers of Comcast's fixed broadband service, but it has already attracted 781,000 mobile customers in just over a year—nearly doubling its subscriber count between the end of 2017 and June 2018. Comcast will also be able to leverage its large stock of 600 MHz licenses to vastly expand its mobile footprint and provide more mobile services using its own facilities. In addition, Charter recently activated its MVNO agreement with Verizon, and Altice announced plans to launch its HMNO service relying, in part, on the Sprint network in 2019.

• Cable HMNOs have complementary assets that will make them strong competitors. Comcast and Charter are already well-positioned to be effective competitors in the wireless market because they:

- have an existing base of over 57 million customers and a fixed network that passes almost an equal number of potential customers;
- have high quality, low-latency fiber and coaxial cable networks that greatly reduce the costs of expanding their customer base;
- already have the right to install facilities in public rights of way, which can accelerate each company's ability to upgrade, expand, and densify its wireless network;

- possess the ability to provide double, triple, and even quadruple play bundles for services including, traditional video, fixed voice, fixed broadband and mobile; and
- are creating mobile platform partnerships with each other and are actively investing to expand their wireless capabilities through the combined use of licensed and unlicensed spectrum.

• HMNOs should be considered as part of the relevant mobile services market. Cable HMNOs' entry into the wireless market has already increased competition. The impact of this intensified competition on price discipline will grow in the next couple of years. Accordingly, any analysis of the mobile telephony/ broadband market must at the very least include HMNOs.

02.

INTRODUCTION

The proposed merger between T-Mobile and Sprint has brought renewed attention to issues of competition in wireless telephony/ broadband. The technology and services in this marketplace, as well as the communications market generally, have evolved and continue to evolve quickly. At this time of change, it is worth taking a fresh look at the new landscape of mobile services.

In 2010, the FCC decided to not consider Mobile Virtual Network Operators when analyzing the competitiveness of the wireless market. The argument made for this exclusion was that MVNOs relied entirely on Mobile Network Operators for wholesale access to facilities and, therefore, had no ability to compete with MNOs in terms of network investments and upgrades.

MVNOs and MNOs partner together because it is mutually beneficial for them to do so. This remains true for cable MVNOs and MNOs. However, the relative bargaining power and ability to compete directly with MNOs has changed with the launch of mobile services by cable operators through MVNO agreements within the last eighteen months. By leveraging their own facilities-based backhaul and fronthaul infrastructure, cable operators have already started to siphon off mobile customers from incumbents. Moreover, cable operators are working to reduce their long-term reliance on MNO wireless networks by: (1) partnering with each other to provide more national footprints;

(2) aggressively expanding their ability to provide wireless services, primarily over their existing fixed broadband networks using Wi-Fi hotspots; and (3) even experimenting with adding LTE radios and 5G small cells to their networks.

This report considers the role of both traditional MVNOs and the new role of cable Hybrid Mobile Network Operators in providing direct competition and imposing price discipline on MNOs. Increasing substitutability between mobile and fixed services is undeniably leading to greater competition in the provision of both wireless and fixed services. As such, the marketplace for wireless telephony/broadband must now take into account the new role that cable operators are playing in this market, whether labeled MVNOs or not.

BTIG directly addresses the issue of the pricing discipline that cable operator offerings of mobile services will have on MNOs:

The re-entry of cable operators into wireless is obviously not just about capturing a share of the paltry industry growth, it's about taking customers from the incumbents and holding back the inevitable rise in Pay TV churn, an industry in the midst of a major disruption. The real concern for wireless investors is therefore not about cable's share of industry growth, but rather whether cable operators will reverse the downward trend of record low wireless churn and induce price cuts by the wireless operators.[1]

A. CURRENT MARKETPLACE FOR COMMUNICATIONS SERVICES

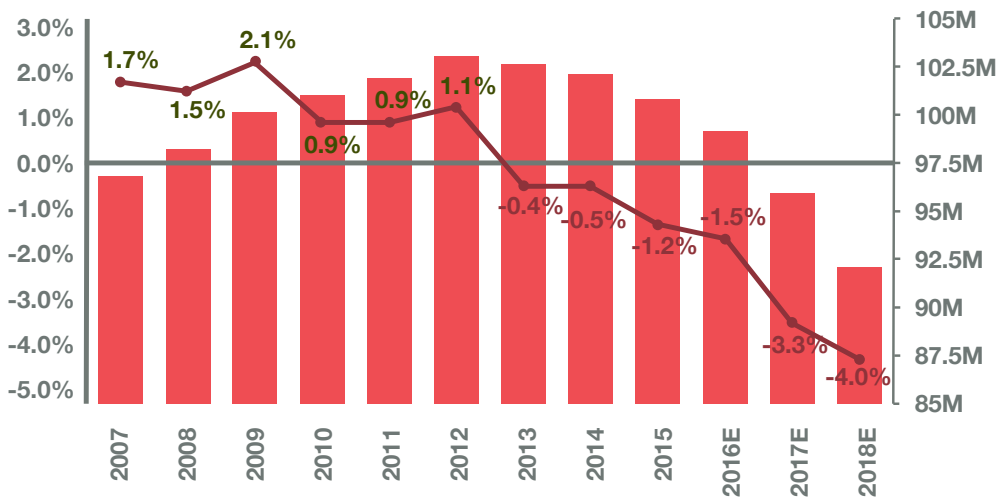
Before discussing the role of MVNOs, and, in particular, the entry of cable operators into wireless services, it is worth providing an overview of the communications market more generally.

Traditional, TDM-based landline telephony has declined rapidly due to substitution to IP, VOIP, and wireless services.[2] The Centers for Disease Control and Prevention estimate that, as of the second half of 2016, over half of U.S. households had mobile telephony *exclusively.*[3] Relying solely on mobile telephony is especially true of younger households. Hence, the substitution away from traditional landline telephony will continue in the near future.

Similarly, the development of video offerings on the internet and over the top (OTT) streaming services has hastened a steady decline in traditional pay television (TV) subscriptions (see Figure 1) that began with the emergence of direct broadcast satellite (DBS) and telco competition in the video market.[4]

FIGURE 1. TRADITIONAL VIDEO SUBSCRIBERS

Source: *See* McAlone, *infra note* 4, at Figure 7.



Traditional cable providers' share in pay TV has dropped from approximately 93% in 1995 to 69% in 2006 to 54.1% in 2017 as satellite multichannel video programming distributors (MVPDs) and OTT services have gained market share.[5] As we see in Figure 2, the top three providers based on first quarter 2018 video subscriptions are Netflix, Amazon, and DirecTV. In this same period, content costs have risen sharply.[6] The decline of traditional video subscriptions, combined with rising content costs and the increasing use of mobile services

as a substitute for fixed broadband service,[7] increases pressure on cable operators to develop their own mobile service offerings.

At the same time, demand for fixed broadband and mobile telephony/broadband has increased steadily.[8] Providers are aware that the quality and price of "connectivity" are driving consumer decisions. Providers are also aware that, while consumers are quite sensitive both to price and quality of service, they are less concerned with the underlying technologies being used by providers to achieve this connectivity.

FIGURE 2. TOP 10 VIDEO SUBSCRIPTION SERVICES 2018

Source: *SNL Kagan and Company-Reported Data, Q1 2018,* NCTA, https://www.ncta.com/chart/top-10-video-subscription-services (last visited July 7, 2018).

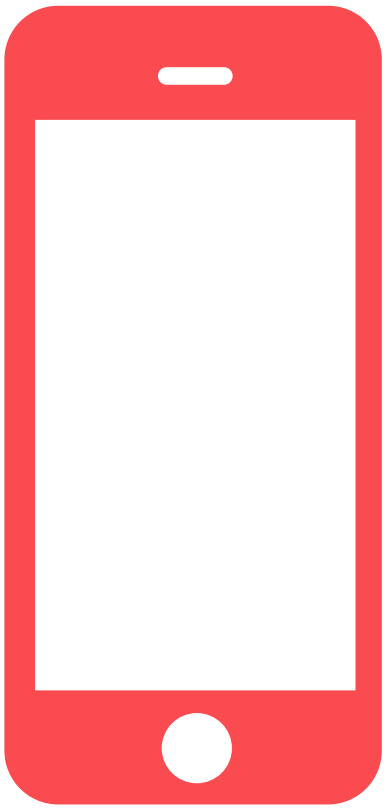
#	SERVICE	SUBSCRIBERS	#	SERVICE	SUBSCRIBERS
1.	NETFLIX	56.7M	6.	CHARTER	16.4M
2.	AMAZON	26M	7.	DISH	10.9
3.	DIRECTV	25.4M	8.	VERIZON FIOS	4.6M
4.	COMCAST	22.3M	9.	COX	3.8M
5.	HULU	20M	10.	ALTICE	3.6

Higher income households tend to have subscriptions to both fixed broadband and wireless telephony/broadband, while younger adults, non-whites, and lower-income households are more likely to *exclusively* use wireless telephony/broadband to connect to the internet.

The Pew Research Center reports:

As the adoption of traditional broadband service has slowed in recent years, a growing share of Americans now use smartphones as their primary means of online access at home. Today one-in-five American adults are "smartphone-only" internet users – meaning they own a smartphone, but do not have traditional home broadband service.[9]

In 2016, BTIG analysts stated, "We believe the pace of Wi-Fi investment by cable operators will quicken as it becomes more apparent that the wireless industry is developing a credible threat to the wired broadband market."[10] The FCC's *2018 Broadband Deployment Report* still concludes that mobile broadband service is not a full substitute for fixed service.[11] However, technological advances are allowing mobile broadband services to become better substitutes for fixed services. The fact that 20 percent of American adults are "smartphone-only" internet users demonstrates that some households do view mobile broadband as a reasonable substitute for fixed broadband, given their preferences.[12]



20%

OF AMERICAN ADULTS ARE "SMARTPHONE-ONLY" INTERNET USERS

This has been recognized by market analysts and places additional pressure on providers of fixed broadband services, such as cable operators, to deploy wireless services.[13]

As mobile and fixed services become better substitutes, consumers will care only about the price and quality of the connectivity and the potential bundling of services when making their purchasing decisions. Providers who are able to offer high quality connectivity at lower prices (especially in the presence of bundling options) will be particularly well placed to compete in this market for connectivity.

B. THE FCC'S DEFINITION OF MOBILE TELEPHONY/ BROADBAND AS OF 2017

MVNOs are wireless communications service providers that do not own the wireless network infrastructure over which they provide services. MVNOs instead purchase network capacity at wholesale rates from MNOs in order to provide their own wireless services.
Beginning in 2010, the FCC explained that it did not consider that MVNOs imposed price discipline on MNOs:

MVNOs are not counted as separate competitors from their hosting facilities-based providers in our analysis of market structure. MVNOs are mobile wireless service competitors which, like facilities-based providers, compete for subscribers. However, because MVNOs purchase their mobile wireless services in wholesale contracts from facilities-based providers, the ability of MVNOs to compete against their host facilities-based provider is limited. Also, MVNOs do not compete through network investments and upgrades as do facilities-based providers.[14]

In the 2017 *Twentieth Mobile Report*, the FCC recognized that there is

now a "broader mobile wireless ecosystem"[15] but still chose not to include MVNOs in its analysis of competition in mobile wireless services:

Following widespread industry practices, the Commission generally attributes the subscribers of MVNOs to their host facilities-based service providers, including when it calculates market concentration metrics.[16]

It is worth noting that the distinction between MVNOs and MNOs has never been as absolute as suggested, given that even large MNOs have relied on roaming arrangements with other MNOs to help serve their customers. For example, Sprint currently relies extensively on roaming arrangements with AT&T and Verizon.[17] And, as discussed below, even before cable's entry, the resale of wireless services provided competitive pressures on MNOs and, therefore, provided competition to mobile wireless.

THE "BROADER MOBILE WIRELESS ECOSYSTEM" HAS CHANGED DRAMATICALLY WITH THE RECENT ENTRY OF CABLE OPERATORS INTO WIRELESS SERVICES.

Regardless, the "broader mobile wireless ecosystem" has changed dramatically with the recent entry of cable operators into wireless services. Now with cable operators using MVNO agreements in conjunction with their existing fixed broadband networks and Wi-Fi hotspots, the FCC's position on MVNOs is even less tenable. As noted above, in 2010, the FCC maintained that, while MVNOs compete for subscribers, they have limited ability to compete directly with MNOs. The FCC also maintained that MVNOs could not "compete through network investments and upgrades as do facilities-based providers."[18] With cable operators acting as MVNOs, it is no longer the case that MVNOs are 100% reliant on MNOs for the provision of wireless services, nor is it still the case that MVNOs cannot compete through network investments and upgrades. For these reasons, I refer to cable operators offering mobile wireless services as Hybrid Mobile Network Operators.

The remainder of this report is organized as follows: Section 03 discusses the competitive pressure on MNOs from *non-facilities-based* MVNOs. Section 04 discusses the competitive pressure on MNOs from *partially facilities-based* cable operator HMNOs beginning to offer wireless services partially through MVNO agreements with MNOs. Section 05 summarizes my conclusions.

03.

COMPETITIVE IMPACT OF *NON-FACILITIES* BASED MVNOS ON MNOS

As previously mentioned, MVNOs do not own the wireless network infrastructure over which they provide services but rather purchase network capacity at wholesale rates from MNOs.[19] These are voluntary agreements between MVNOs and MNOs based on profit maximizing motives.[20]

Burton, Kaserman, and Mayo explain that, in any industry, resale markets occur "whenever upstream producers choose not to vertically integrate forward (or choose to only partially integrate forward) into the final retail stage. That is, resale exists due to incomplete forward integration by upstream firms."[21]

The decision by upstream firms to not fully vertically integrate is based on many factors, including differences in economies of scale at different stages of production, specialization, contract and transactions costs, and the profitability of price discrimination.[22] Resale moves any market closer to a competitive market equilibrium and lowers the costs of the overall vertical chain. In other words, resale—in any market—imposes price/quality discipline on upstream suppliers.[23]

In the case of mobile services, MNOs sometimes do not pursue potential sales in downstream retail markets because MVNOs add value to MNOs by targeting customers which MNOs would themselves not find profitable to target directly.[24] This reflects different economies of scale at different stages of production and product differentiation. Hence, by increasing the total scale of the MNO market, MVNO agreements help MNOs.[25] With multiple MNOs competing for MVNOs that have access to unique consumer segments, MVNOs are able to obtain competitive wholesale rates. This leads to lower overall prices, due to greater economies of scale in the upstream market, and increased price/quality discipline in the downstream retail market.[26]

RESALE MOVES ANY MARKET CLOSER TO A COMPETITIVE MARKET EQUILIBRIUM AND LOWERS THE COSTS OF THE OVERALL VERTICAL CHAIN. IN OTHER WORDS, RESALE—IN ANY MARKET—IMPOSES PRICE/QUALITY DISCIPLINE ON UPSTREAM SUPPLIERS.

Moreover, the presence of resellers facilitates potential entry of new firms upstream for at least two reasons: (i) by making it easier to overcome substantial sunk costs, resale reduces potential losses associated with sunk costs in event of exit, and (ii) resellers may decide to later invest in their own facilities to (a) ensure quality, (b) reduce transactions costs, and (c) capture possible non-trivial vertical economies.[27] As Burton, Kaserman, and Mayo state, other things being equal, "resellers will tend to be more likely potential entrants than firms that have no association with the upstream market."[28] Since threat of entry applies pro-competitive effects to operators in the market, the additional threat of entry by MVNOs into the upstream market creates even stronger pro-competitive effects.[29] Critically, more actual entry by MVNOs is not necessary for these pro-competitive effects to occur.[30]

The pro-competitive impact of a resale market does not require that the resale market be a large share of the total market for a service. For example, Burton, Kaserman and Mayo point out that in the case of the long-distance wireline industry, by the end of 1997, resellers had a tremendous impact on the long-distance wireline market despite only representing about 9% of total interexchange carrier revenues.[31] Voluntary resale has pro-competitive effects on market outcomes in terms of production cost, service innovations, and/or increased entry or increased threat of entry or expansion at the retail stage and into upstream (facilities-based) markets.

Successful non-facilities based MVNOs have generally focused on providing service to customers who were previously underserved or unserved by MNOs, including small and medium-sized businesses, price-sensitive consumers, expatriates, and tourists. Currently, the largest MVNO in the U.S. is América Móvil SAB de CV. While América Móvil is the fourth largest mobile network operator in the world in terms of total subscribers, it does not own any wireless telecommunications facilities or hold any spectrum licenses in the U.S.[32] In the U.S., it operates as an MVNO sold under multiple brands including TracFone, Straight Talk, Net 10, SafeLink, Simple Mobile, and Telcel América. América Móvil had over 32% of the U.S. MVNO market in 2016.[33] América Móvil is reselling wireless services it leases from AT&T, T-Mobile, Verizon, and U.S. Cellular.[34]

AMÉRICA MÓVIL HAD OVER 32% OF U.S. MVNO SALES IN 2016.

MVNOs, such as those operated by América Móvil, rely on the network facilities of MNOs but compete directly with MNOs for customers based on price, plan features, and customer service. According to Strategic Analytics (May 2018), in 2017 MVNOs comprised 9.6% of total US retail wireless subscriptions and 38% of prepaid subscriptions.[35]

Moreover, while some MVNOs historically focused on prepaid offerings, the differences between prepaid and postpaid subscriptions are no longer of great competitive significance, and, accordingly, there is now increasing competition between the prepaid and postpaid plans for mobile wireless services.[36] In fact, a significant percentage of new postpaid subscriptions are coming from previous prepaid customers.

ACCORDING TO STRATEGIC ANALYTICS (MAY 2018), IN 2017 MVNOS COMPRISED 9.6% OF TOTAL US RETAIL WIRELESS SUBSCRIPTIONS AND 38% OF PREPAID SUBSCRIPTIONS.

With the deployment of 5G networks and the evolution of the Internet of Things (IoT), there will be a new explosion of specialization/differentiation of possible mobile services. Specifically, 5G allows for network slicing, which will allow for even greater specialization of service offerings:

A network slice is a logical network that provides specific network capabilities and network characteristics in order to serve a defined business purpose of a customer. Network Slicing allows multiple virtual networks to be created on top of a common shared physical infrastructure. A network slice consists of different subnets, example: Radio Access Network (RAN) subnet, Core Network (CN) subnet, Transport network subnet.[37]

The deployment of 5G and the feasibility of network slicing within 5G will thus provide significant excess capacity and many new opportunities for MVNOs to satisfy customers with specific needs, in terms of latency, bandwidth, volume, and other features. Hence, opportunities for non-facilities based MVNOs are likely to expand strongly with the deployment of 5G.

MVNOs thus not only participate in offering wireless telecommunications directly, but they also apply direct competitive pressure onto the MNOs. As such, MVNOs should be included in any consideration of the marketplace competition in the wireless telecommunications market.

04.

COMPETITIVE IMPACT OF CABLE HMNOS

Within the last year and a half, cable operators have begun wireless operations using Verizon's mobile network along with their own facilities. These new entries have already begun to and will soon dramatically increase the share of alternatives to MNOs in overall wireless services. Cable operators are MVNOs to the extent that they are leasing access to an MNO's wireless network. However, as fixed broadband providers (especially in combination with Wi-Fi), cable operators are also facilities-based providers of mobile services. This is true in two respects.

Cable operators can provide a large portion of individual mobile transmissions without the use of Verizon's network (in which case they are acting as MNOs). Further, a growing share of mobile data traffic is being offloaded to fixed broadband networks, including traffic originated from a device that is connected to a cellular network.[38] Hence, when providing mobile services, a cable operator is acting as a hybrid MVNO and MNO, or an HMNO.

The "broader mobile wireless ecosystem" mentioned by the FCC changed with Comcast's introduction of its mobile wireless service, Xfinity Mobile, through an MVNO relationship with Verizon in April 2017. The 2017 IBISWorld Industry Report on Telecommunications Resellers notes the increased competition caused by Comcast's recent entry into wireless services:

As the telecommunication sector continues to mature, mobile virtual network operators (MVNOs) will increasingly compete with their upstream infrastructure providers for niche customers. Operators are also expected to encounter new threats from cable companies looking to enter the MVNO market. In early 2017, cable company Comcast began offering unlimited cellular service with Xfinity Mobile over Verizon's LTE network, as part of a deal dating back to 2011. The company is also currently testing its own internet-of-things (IoT) infrastructure network called machine-Q. If Comcast further penetrates the market by providing mobile phone and internet service, competition could significantly increase due to Comcast's already-large user base, strong brand name and economies of scale. Most recently, Comcast announced a knowledge-sharing partnership in the wireless realm with Charter Communications, wherein it would create "common operating platforms; technical standards development and harmonization; device forward and reverse logistics; and emerging wireless technology platforms."[39]

Also partnering with Verizon, Charter Communications just started its HMNO service, Spectrum Mobile, on June 30, 2018,[40] and Altice is reported to be launching its wireless service in early 2019, relying on its own network, the CableWiFi consortium, and a partnership with Sprint.[41]

Comcast and Charter are particularly well positioned to launch wireless networks by leveraging their existing fixed broadband networks. They have additionally established a formal mobile operating platform partnership. This is a natural reaction to increasingly converging markets and concern over potential losses in fixed broadband service as wireless is seen by consumers as a more viable substitute for fixed broadband.

In 2016, BTIG market analysts predicted increasing competition for fixed broadband providers from wireless: “We believe the wireless industry could capture $5 – $12 billion of wired broadband revenue, excluding any Pay TV revenue that could be captured in the form of OTT service offerings.”[42]

COMCAST AND CHARTER ARE ABLE TO OFFLOAD A MAJORITY OF MOBILE DATA TRAFFIC AND CAN EVEN OFFER A PORTION OF MOBILE SERVICE TRANSMISSIONS, WITHOUT EVER NEEDING TO CONNECT TO THE VERIZON NETWORK.

The Comcast and Charter HMNOs inherently differ from typical MVNOs, specifically because their existing fixed broadband networks, combined with existing extensive Wi-Fi networks, enable them to not rely 100% on the Verizon network. They are able to offload a majority of mobile data traffic and can even offer a portion of mobile service transmissions, without ever needing to connect to the Verizon network. Additionally, Comcast spent over $1.7 billion in the Incentive Auction for 600 MHz spectrum licenses, and both cable operators have demonstrated interest in 3.5 GHz spectrum, along with other future spectrum options relevant to 5G. As a result, they will soon be able to self-supply more pieces of their network.

From the perspective of the traditional definition of the wireless market, it is important to note that 5G networks will rely on many small cells that offload data to backhaul, such as a fixed broadband network. This means that the value of a 5G network will be only as good as the backhaul to which it is connected.[43]

Comcast and Charter have (a) large established (and independent) market presence in large areas of the country, (b) existing high-speed, low-latency hybrid fiber-coaxial broadband networks, (c) a large stock of Wi-Fi hotspots in the major U.S. markets for offloading mobile data onto

fixed broadband networks, (d) the ability to bundle mobile telephony/broadband with fixed voice, video, and fixed broadband, and (e) a mobile operating platform partnership to achieve both a national footprint and achieve greater economies of scale in the provision of mobile services.

A. CURRENT CABLE PROVIDED WIRELESS SERVICE

In 2011, SpectrumCo, a joint venture of cable companies Comcast, Time Warner Cable, and Bright House Networks, sold its 122 AWS spectrum licenses (covering 259 million people) to Verizon for $3.6 billion.[44] As part of the agreement, the cable companies acquired the option of selling Verizon's service as MVNOs. [45]

In April 2017, Comcast began offering Xfinity Mobile wireless service using its existing MVNO agreement with Verizon: "Xfinity Mobile is a new kind of network that combines America's largest, most reliable 4G LTE with access to the most Wi-Fi hotspots — so you can use less data and save money on the go."[46] Comcast's existing wireline broadband network covers parts of 40 states, plus Washington, D.C., and has 18 million Wi-Fi hotspots on which to download wireless service. Hence, Comcast provides wireless services partially through its resale agreement with Verizon and partially as a facilities-based provider—despite its (incorrectly) perceived status as an MVNO.

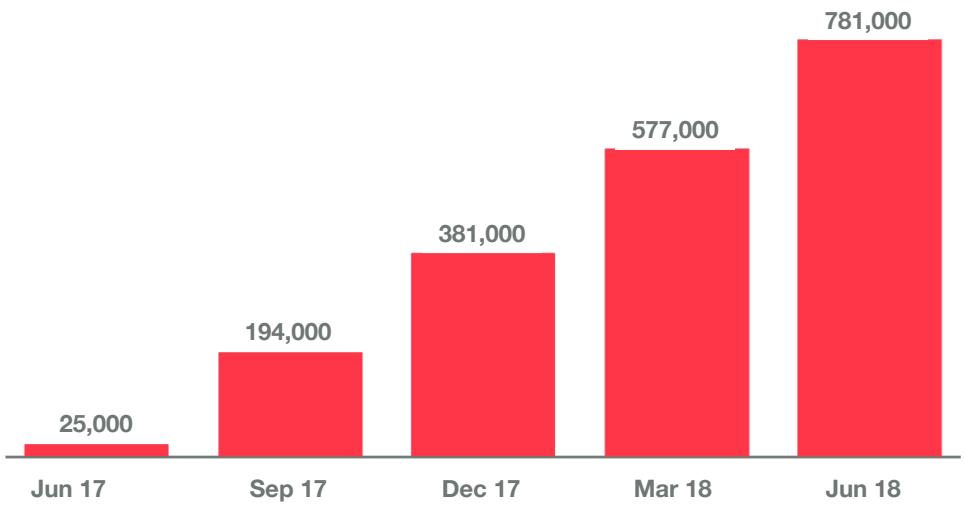
Xfinity Mobile is currently only available to Comcast internet customers. Despite this initial limitation, and having only introduced this service in April of 2017, there were 781,000 Xfinity mobile subscribers by the end of the second quarter of 2018.[47] The addition of 204,000 Xfinity subscribers in the second quarter of 2018 exceeded that of 199,000 at Verizon and 46,000 at AT&T.[48]

Charter just launched its HMNO service, Spectrum Mobile, on June 30, 2018.[49] Like Comcast, Charter is relying partly on its 2011 agreement with Verizon and currently only offers service to existing Charter internet customers. Charter is present in 41 states and has approximately 250,000 Wi-Fi hotspots.[50] Moreover, through the "CableWiFi" agreement, Charter and Comcast customers can roam on each other's Wi-Fi networks (as well as those of Optimum and Cox) free of charge.[51]

In May 2017, Comcast and Charter announced an "agreement to explore potential opportunities for operational cooperation in their respective wireless businesses to accelerate and enhance each company's ability to participate in the national wireless marketplace."[52,53] Charter CEO Tom Rutledge stated that the partnership "will . . . enable us to provide more competition and drive costs down for consumers at a national scale as current wireless operators."[54] Rutledge further explained to investors that the company's MVNO relationship and partnership with

FIGURE 3. COMCAST'S XFINITY MOBILE SUBSCRIBERS (IN THOUSANDS)

Source: Company reports; BTIG.



Comcast yields "opportunities on a national level, which neither Comcast nor Charter has as regional players, that come together in this MVNO, and we'd like to take advantage of them."[55]

In April 2018, Comcast and Charter entered into a formal mobile operating platform partnership focused on the development and design of back end systems to support both of their mobile networks:

Through the agreement, Charter and Comcast will work together to cost-effectively develop an efficient and scalable software platform, and related backend systems, which will power each company's mobile-related customer sales and support platforms, device logistics and warehousing, and billing. The operating platform developed by the partnership will serve as the systems interface for current and any future MVNO (mobile virtual network operator) partners.[56]

Overall, analysts are predicting that cable operators will play an increasingly large role in mobile services. According to FierceWireless:

"Wireless executives had been dismissive of cable's foray into wireless, and the economics of the MVNO model in an unlimited world; however, following Comcast's early success (Comcast added more phone customers than Verizon and AT&T in 2017), we think the companies, and investors, are more sensitive to this risk," wrote the Wall Street analysts at Morgan Stanley Research in a note to investors this morning. Specifically, the firm said it estimates that cable MVNOs will add around 2.2 million mobile phone customers in 2020, or almost 50% of the industry's total net customer additions.[57]

Altice, with around 5 million customers in 21 states, is the nation's fourth largest cable operator. Altice signed an MVNO deal with Sprint in late 2017 and plans to launch mobile services in 2019. According to FierceWireless, in this MVNO agreement Sprint also plans to "leverage the Altice USA broadband platform to accelerate the densification of its network."[58]

Altice CEO, Dexter Goei, explains that Altice is planning on entering the wireless market in a different manner from Comcast and Charter:

On Altice mobile, we're on track to launch next year and will have 4G LTE and voice-over-LTE services available straight away. Recall we have a full infrastructure-based MVNO, which has attractive economics and flexibility features for us. We have a dedicated and experienced mobile management team which will lead the development, launch and ongoing mobile strategy. In terms of network development, the densification of Sprint's network, which we're helping with our AirStrand deployment is comfortably ahead of schedule as are the upgrades to and expansion of our Wi-Fi network. We are also testing CBRS spectrum with equipment in a 3.5 gigahertz band as this may be good complementary capacity for us.[59]

B. WI-FI

High and increasing levels of data traffic are being generated by mobile devices, primarily because of increased video streaming. Cisco's Visual Networking Index (VNI) for 2017 estimates that 60% of 2016 global mobile data traffic was video. Cisco further estimates that video will represent 78% of all mobile data traffic by 2021.[60]

OFCOM ESTIMATES THAT APPROXIMATELY 75% OF THE TIME, DATA CONNECTIONS OCCUR WHILE MOBILE DEVICES ARE CONNECTED TO WI-FI.

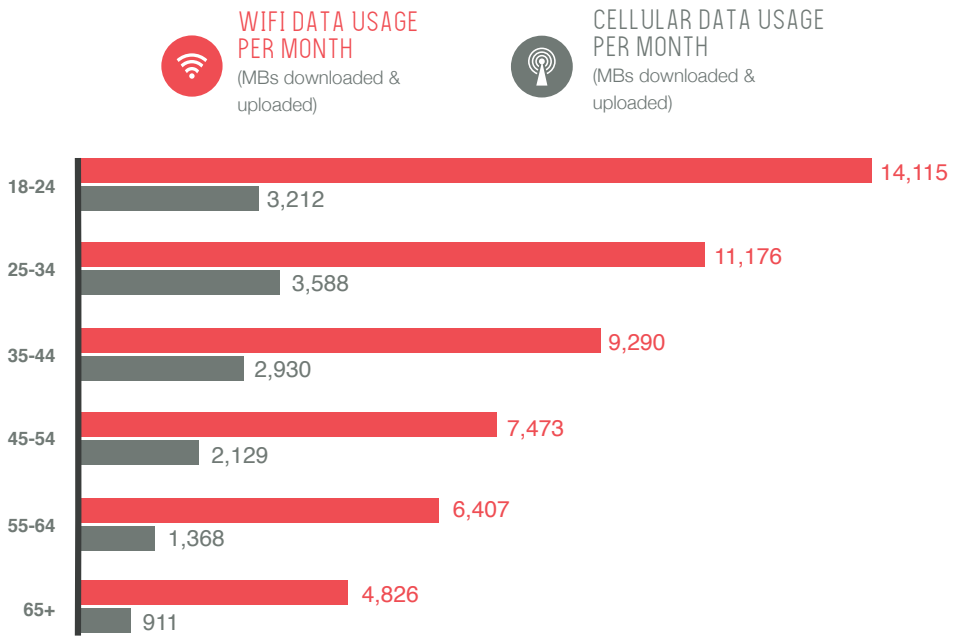
Ofcom estimates that approximately 75% of the time, data connections occur while mobile devices are connected to Wi-Fi.[61] Similarly, Cisco VNI estimates that around 60% of traffic generated by mobile devices is offloaded.[62]

In the United States, up to 80% of smartphone data traffic in 2016 traveled over Wi-Fi rather than cellular networks according to the NPD Group.[63] Examining U.S. data usage of 45,000 Android users over the age of 18 over the month of August in 2016, Nielsen estimates that almost 80% of all mobile data traffic was carried over Wi-Fi.[64]

Figure 4 shows the breakdown of the mobile data traffic carried over cellular versus Wi-Fi networks based on the age of the user.

FIGURE 4. MOBILE DEVICE DATA TRAFFIC OVER CELLULAR AND WI-FI NETWORKS BY AGE OF USER

Source: Nielsen



New wireless technologies, such as 5G, LTE-U, and LAA, increasingly combine the use of licensed and unlicensed spectrum. As such, offloading of data from licensed spectrum to unlicensed spectrum and then fixed broadband is likely to increase over time.

Even before cable's official entry into wireless services, analysts were highlighting cable's investments in Wi-Fi hotspots:

The cable industry is also extending the public footprint of its Wi-Fi hotspots by upgrading the Wi-Fi routers in customers' homes to products that broadcast a separate SSID (network name) that allow public use. Comcast has been the most aggressive in this endeavor, announcing a 5 million increase [in] XFINITY hotspot locations in 2015. We believe the vast majority of this 5 million increase is the shipment of new "higher speed" Wi-Fi Routers to existing customers. The Comcast customer receives a higher speed router, but most likely don't realize that it also enables outsiders to use the wired connection from their home as well as their Wi-Fi router.[65]

From a supply perspective, offloading from cellular to fixed networks add available capacity, reduces congestion of limited spectrum, provides economies of scope, and, notably, reduces reliance on cellular MVNO relationships. Cable operators can completely bypass the MNO network for a certain percentage of individual voice or data transmissions. Hence, the combination of a fixed broadband network with unlicensed spectrum use can help cable HMNOs reduce both their MVNO costs and their strategic reliance on MNOs.

From a demand perspective, consumers are both able and willing to use Wi-Fi offloading as a partial—and in some situations, full—substitute for cellular service. Based on the observed substitutability from the consumer's perspective, Furchtgott-Roth argues that Wi-Fi offloading disciplines prices of wireless services and should therefore be considered part of the same economic market.[66]

Given the already significant presence of these (18 million plus[67]) Wi-Fi hotspots in major markets, combined with high-speed, low latency hybrid fiber coaxial networks (Charter in 41 states, Comcast in 40 states, plus Washington, D.C.) and the national wireless network provided by Verizon, the Comcast and Charter partnership provides them a greater combined geographic reach and greater economies of scale for both companies' wireless services. Given their economies of scale, as well as their existing economies of scope, both Charter and Comcast can already provide high quality wireless service and may eventually be able to do so at lower cost than traditional non-facilities based MVNOs.

WITH CABLE OPERATORS USING MVNO AGREEMENTS IN CONJUNCTION WITH THEIR EXISTING FIXED BROADBAND NETWORKS AND WIFI HOTSPOTS, MVNOS CAN NO LONGER BE IGNORED WHEN CONSIDERING COMPETITIVE PRICING AND QUALITY PRESSURES IN THE PROVISION OF WIRELESS SERVICES.

Moreover, these cable companies have the opportunity to target additional Wi-Fi hotspot, high-power LTE, and/or 5G radio deployment in areas where they see that they are relying most on the Verizon network. Cable operators already have the necessary rights to install equipment in the rights of way, which surmounts at least one barrier to expansion that MNOs would face when trying to densify their networks.

In early 2017, even before Comcast launched its wireless services, market analysts noted:

[I]nvestors should also start to consider the possibility that cable operators could build new wireless networks as an evolution of an MVNO strategy, which is expected to launch this year. LTE radios are cheap and the cost of the new wireless networks are primarily driven by the labor of laying the fiber, an asset in which cable operators have already invested.

Capital investment has been on the rise by cable operators as they extend fiber deeper into the network, thereby creating a readymade backbone for a wireless network. Comcast owns over 149,000 route miles of fiber deployed . . . . That provides a strong advantage for Comcast as wireless networks densify. Placing Wi-Fi hotspots on existing fiber can offer some wireless coverage, but we believe Comcast could cover a substantial portion of the more than 125 million people that live within its cable footprint by deploying higher power LTE over licensed spectrum. There are even options to hang LTE radios from the hanging fiber strands . . . . This would obviate the need for difficult right of way approvals. We believe it's plausible that Comcast could spend less than $2 billion to provide coverage across a meaningful portion of its footprint.[68]

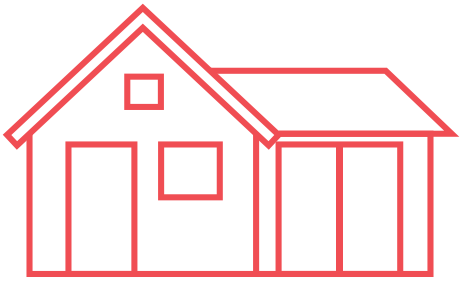
After the release of Comcast's 2018 second quarter results, BTIG (July 26, 2018) estimated that "Comcast's cumulative Cash EBITDA losses from its wireless business have topped $1.2 billion since the launch in May of last year."[69] Still, BTIG argues,

Comcast is unlikely to pull its wireless efforts given the pending threat that 5G presents to its wired broadband business. We continue to believe it is logical for Comcast to build a wireless network on top of its already elevated and rising investment in fiber. Its peer Charter has been more open about those plans and stated yesterday that it is expanding its LTE trial to New York and Los Angeles.[70]

Such targeted deployment, should it occur, will reduce MVNO costs for the cable companies and will reduce their reliance on Verizon generally. Cable companies will provide significant price discipline on wireless telephony/broadband. Again, as suggested by market analysts in early 2017, "if cable operators were able to leverage initial MVNO success into an overbuild strategy, this would provide a new threat to the wireless industry and remove a consolidator from the market."[71]

C. REDUCED ENTRY/ EXPANSION COSTS FOR CABLE OPERATORS

Both Comcast and Charter have large fiber and coaxial based networks with large existing customer bases and an even larger number of homes passed. As of July 2018, Charter has 840,000 miles of fiber and coax-based network infrastructure passing 50 million homes and businesses.[72] As of March 31, 2018 Comcast also passes over 50 million homes.[73]



AS OF MARCH 31, 2018 COMCAST PASSES OVER 50 MILLION HOMES.

AS OF JULY 2018, CHARTER HAS 840,000 MILES OF FIBER AND COAX-BASED NETWORK INFRASTRUCTURE PASSING 50 MILLION HOMES AND BUSINESSES.

Figure 5 shows the most recent subscriber data for Comcast and Charter. Combined, they have existing relationships with over 57 million customers, almost 50 million of which are fixed broadband subscribers. This represents less than half of the total homes passed by the two cable operators, indicating that they have the opportunity to substantially increase broadband subscribership, subject to competitive offerings and consumer demand.

A majority of Comcast's and Charter's customers, 69% and 59% respectively, subscribe to a bundle of at least two services. 36% of Comcast and 33% of Charter's customers had bundles of three or more services.[74] This demonstrates both the strategic value of bundling, and the fact that there is a large existing base of cable customers who could relatively easily add mobile telephony/broadband services to their current services.

FIGURE 5. COMCAST AND CHARTER SUBSCRIBERS AND BUNDLING, Q2 2018 (MILLIONS)

Sources: Comcast Corporation, 2018Q2 Form 10-Q, at 30 (July 26, 2018) (as of June 30, 2018); Charter Communications, Inc., 2018Q2 Form 10-Q at 32 (July 31, 2018) (as of Aug. 23, 2018).

IN MILLIONS	COMCAST	CHARTER	COMBINED
Total Customers	29.80	27.62	57.42
Residential	27.56	25.87	53.43
Within Residential:			
Voice	11.48	10.33	21.81
Video	22.12	16.21	38.33
Internet	26.51	23.07	49.58
Percent with Bundles	**69%**	**59%**	**64%**
of which:			
Double	33%	26%	29%
Triple and Quad	36%	33%	34%

For these customers, the cost of switching/adding mobile services to their existing fixed services is reduced, relative to switching to a new mobile service that does not offer another service to which they are already subscribed. Moreover, existing consumers anticipate further potential benefits from bundling multiple communications and video services.

Comcast attracted 781,000 wireless subscribers within a little over a year of launching Xfinity Mobile. This achievement is testament to Comcast's strong market presence and ability to attract consumers to its mobile service by bundling its services. Moreover, while Comcast currently has over 26 million fixed broadband customers, its cables pass over 50 million homes and businesses, implying a broadband penetration rate of just over half of homes and businesses passed. This means that Comcast can increase its volume of mobile customers significantly without material additional capital expenditures.

D. ABILITY TO BUNDLE BY CABLE OPERATORS

Cable operators have the ability to offer triple and even quadruple plays of fixed broadband, video, fixed telephony, and now mobile telephony/broadband. As previously shown in Figure 5, 69% of Comcast's and 59% of Charter's residential customers currently subscribe to a bundle of at least two services. The ability to offer triple or quadruple plays can help cable operators: (a) increase the services purchased by their existing customer base; (b) expand their existing customer base; (c) reduce churn for both existing and new customers; and (d) perhaps slow the shedding of services like video and wired (VOIP) phone by customers who may be primarily interested in fixed broadband and/or mobile telephony/broadband service.

Economies of scope across fixed and mobile broadband are present, making it possible for cable networks to offer fixed and mobile bundles at lower prices than competitors that do not offer both services.

EVEN IN THE ABSENCE OF ECONOMIES OF SCOPE, BUNDLING CAN ATTRACT CONSUMERS WANTING GREATER STREAMLINING OF BILLING, SERVICE, ETC. AND REDUCE CHURN FOR CUSTOMERS SUBSCRIBED TO A BUNDLE.

Even in the absence of economies of scope, bundling can attract consumers wanting greater streamlining of billing, service, etc. and reduce churn for customers subscribed to a bundle. In a bundled setting, churn can be the abandonment of a service provider or the abandonment of a single service within the bundle by an existing subscriber.

For subscribers with a strong preference for bundling of video, fixed voice, fixed internet and mobile, quadruple play offerings of cable operators are a strong draw, and such consumers will likely not abandon their bundle easily. The FCC's Eighteenth Video Competition Report states:

In response to statements by Charter and Comcast regarding the offering of wireless services – a move from triple play bundles to quadruple play bundles – SNL Kagan maintains that the "move should help reduce churn, with a larger number of products on a single bill typically associated with greater customer retention."[75]

Moreover, once a customer has a triple or quadruple play bundle, they are likely to hold on to individual services longer than they would otherwise. The trend has been for fixed broadband and wireless services to substitute for traditional video and landline telephony. However, when all four services are included in a bundle this may slow the speed with which consumers are shedding traditional video and/or fixed voice services.

Prince and Greenstein use cross sectional survey data from 2007 to 2009 in an attempt to analyze the impact of triple-play bundles on churn. Given the dates of the survey data, this analysis is not capturing the more recent periods with even stronger declines in landline telephony and traditional pay-television. Still, the authors conclude that:

[B]undling does reduce churn for the three services in a triple-play bundle. As we might have expected, the effect was most pronounced for adoption of these services from the cable company (as compared to adoption overall). We also stressed an important empirical effect in our data that has received little attention in the

theoretical literature. The effect was only evident in our data when services experienced "turmoil" in the form of significant diffusion (broadband) or contraction (wired telephone and pay television in 2009, due to recession). The pronounced effects during market contractions highlight bundling's potential role in helping mitigate shrinking markets.[76]

THE DECLINE OF TRADITIONAL VIDEO SUBSCRIPTIONS, COMBINED WITH RISING CONTENT COSTS, HAS BEEN PUTTING DOWNWARD PRESSURE ON CABLE OPERATOR PROFITS. MOREOVER, THE INCREASED THREAT THAT MOBILE BROADBAND MIGHT SUBSTITUTE FOR FIXED BROADBAND GIVES CABLE OPERATORS GREATER INCENTIVES TO OFFER WIRELESS SERVICES TO PROTECT (AND POTENTIALLY EXPAND) THEIR EXISTING CUSTOMER BASE.

The ability of cable to bundle video and wireline VOIP services with fixed broadband and mobile telephony/broadband services will likely help cable operators reduce the speed with which they lose revenue from traditional video and VOIP services.

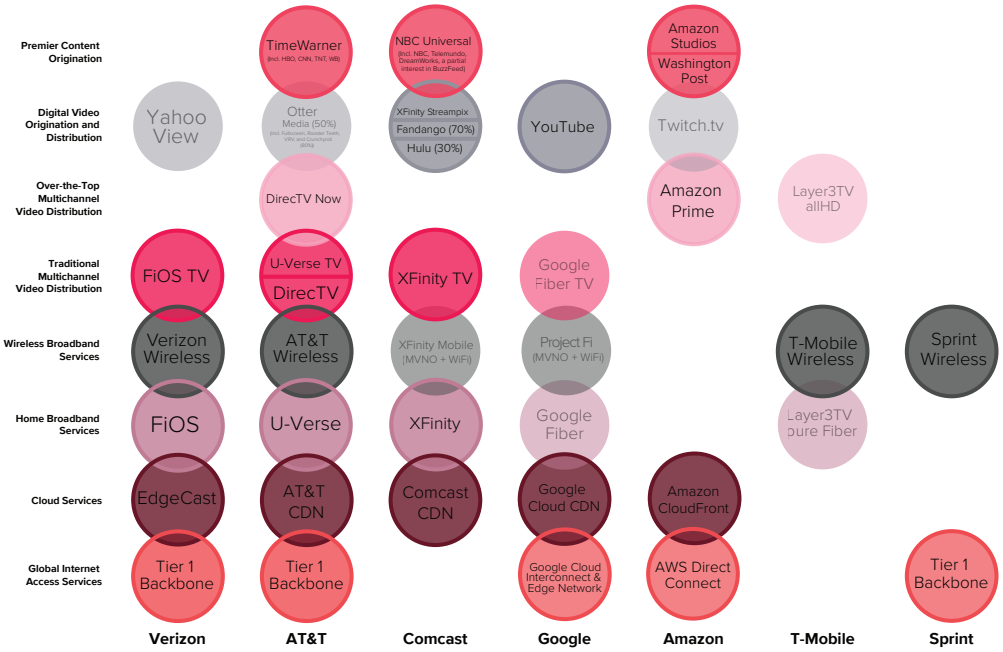
The decline of traditional video subscriptions, combined with rising content costs, has been putting downward pressure on cable operator profits.[77] Moreover, the increased threat that mobile broadband might substitute for fixed broadband gives cable operators greater incentives to offer wireless services to protect (and potentially expand) their existing customer base.

By combining a mobile broadband product with fixed broadband and an extensive array of linear and on-demand video services, Comcast and Charter can provide a suite of services that are unmatched. Comcast and Charter are therefore not only able to offer unique packages of services but can also experiment with retail pricing in a way that traditional MVNOs offering only a single product or limited bundle cannot.[78]

The economic value of being able to offer combinations of content and services is evident in the preponderance of vertical integration which has already occurred between firms in media, distribution, and tech. (See Figure 6). We have seen increasing mergers and acquisitions, as well as partnering arrangements, between content, distributors, and tech providers. This reflects the general convergence that is occurring between these once well delineated markets. Moreover, this convergence highlights the key roles that bundling, product differentiation, and access are currently playing and demonstrates a market response to consumer demand for single access connectivity.

FIGURE 6. INCREASING PARTNERSHIPS AND VERTICAL INTEGRATION

Borderless circles represent lower scale market participants.
Source: Hogan Lovells (2018).



E. RETURNED ENTRY INTO SPECTRUM LICENSE OWNERSHIP

While Comcast and Charter sold their 700 MHz licenses to Verizon in 2011,[79] Comcast just spent over $1.7 billion in the Incentive Auction for 600 MHz licenses.[80] Hence, Comcast has the opportunity in the near future to use these licenses to reduce its MVNO payments to Verizon and/or supplement its existing MVNO network provided by Verizon.

Similarly, both Comcast and Charter have expressed interest in making use of the 3.5 GHz Citizens Broadband Radio Service (CBRS) band once it is made available to sharing through either Priority Access Licenses (PALs) or unlicensed use through the Generalized Authorized Access (GAA) tier.[81] Charter has been conducting tests of its own wireless network and services, primarily in the 3.5 GHz band.[82]

FierceWireless suggests that:

Such efforts by Comcast and Charter may be geared toward further reducing their network usage payments to Verizon by forcing their mobile customers off of Verizon's LTE network and onto a 600 MHz network or a 3.5 GHz network, as both operators already do with their public Wi-Fi networks. Or they may use their spectrum for something else, like expanding an IoT network or offering a fixed wireless internet service.[83]

Efforts by cable operators to expand their own facilities networks for wireless services underscore the strength that cable HMNOs have, relative to non-facilities based MVNOs, to negotiate wholesale agreements. These investments in facilities also importantly demonstrate the additional pricing and quality discipline that the entry of cable HMNOs will have in the provision of mobile services.

F. PLANNED 5G DEPLOYMENT

The communications marketplace is currently focused on the deployment of 5G. This technology involves the installation of many small cells but will allow for much improved capacity, speed, and latency, relative to 4G LTE. 5G deployment plans are being considered not only by MNOs, AT&T, Verizon, T-Mobile, and Sprint, but also by cable operators Comcast and Charter, and satellite operator DISH. As previously discussed, both cable operators are well positioned in this realm. They are able to use their existing customer base, fixed broadband networks, ability to bundle, and their mobile partnerships to leverage their MVNO access to Verizon's wireless network. Comcast is developing an IoT infrastructure network called machine-Q.

As previously mentioned, Comcast recently spent $1.7 billion in the Incentive Auction for licenses in the 600 MHz range and has demonstrated interest in the 3.5 GHz band, although it has not specified whether it is more interested in the unlicensed or licensed portion of the band.

Charter's CEO, Tom Rutledge, explains that Charter's plans are based on

[T]he integration of small cell architecture using unlicensed and licensed spectrum working together interchangeably with our advanced DOCSIS roadmap to create high capacity, low latency product offerings. We expect that over time, our existing infrastructure will put us in a unique position to economically deploy new powerful products that benefits from small cell connectivity. . . . [O]ur thought is that, we may want to take additional licensed spectrum and combine it with Wi-Fi spectrum to create an even broader, in-home, in-business, and mobile platform. . . . [Charter is] working on the integration of licensed and unlicensed spectrum into the same radios.[84]

Charter has focused significant attention on the 3.5 GHz CBRS band. Charter has been system testing in that band for both mobile and fixed uses and reports that it has already achieved speeds of 25 Mbps down/3 Mbps up "at significant distances."[85] According to filings with the FCC, "Charter believes mobile uses of the CBRS band could combine well with Wi-Fi, allowing a new entrant, like cable, to deploy 3.5 GHz spectrum quickly and cost effectively."[86] Charter is also testing 5G services in the 28 GHz band.[87]

THE TECHNOLOGICAL WALLS THAT ONCE EXISTED BETWEEN FIXED AND MOBILE ARE DISSOLVING QUICKLY AND WILL SOON BE BUT VESTIGES OF ANTIQUATED JARGON.

The fact that MNOs, cable operators, and a DBS provider all have plans to offer 5G wireless services underscores the fact that existing MNOs are not the only competitive force in wireless services. The role of HMNOs (and possibly DISH) in the wireless market, whether labeled MVNOs or anything else, will be significant in providing competitive discipline in mobile services. The technological walls that once existed between fixed and mobile are dissolving quickly and will soon be but vestiges of antiquated jargon.

05.

CONCLUSION

Consumers are interested in improving efficiency and savings by bundling all of their communication (and entertainment) needs. At present, residential and business consumers are tending to favor fixed broadband for connecting to the internet from their primary physical locations (i.e., fixed residences and business locations) and mobile telephony/broadband for connecting to the internet while outside their primary physical locations. This is a function of both the quality and price of service that consumers see when using these technologies and providers. However, as technology, infrastructure, and vertical integration/partnering evolve, consumers will face more similar levels of quality and pricing for services providing "connectivity," regardless of whether the provider is officially considered to be a mobile wireless network operator, a cable operator, an MVNO, a satellite operator, or a 5G operator. Increasing substitutability between wireless and fixed services, along with the eventual hybridization of wireless and fixed broadband networks, leads to increasingly direct competition across all of these providers in a single market for providing connectivity to consumers. Much of this competition will be in the form of differentiation of services. Still, there will be direct competition for customers. Viewing or defining all of these markets as independent of one another is quickly becoming anachronistic.

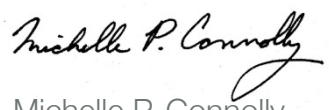
Competition does not increase linearly (or even necessarily at all) simply with the addition of an extra firm. However, even threat of entry by efficient firms imposes pricing discipline on current providers. Acting as hybrid MVNO/

MNOs, cable operators have already begun siphoning off some of the growth of mobile subscribers from MNOs. The launch of Comcast and Charter (and Altice in 2019) into wireless services has already increased, and will in the next few years continue to increase, the amount (and threat) of competition in the more narrowly defined wireless market. In turn, both current entry and the threat of continued entry by cable operators have and will continue to impose increasing price discipline in wireless services.

Comcast and Charter have large and powerful wireline broadband networks, existing customer bases, and branding that they are using to leverage their MVNO relationship in their provision of wireless services. Equally important, Comcast and Charter have a unique ability to offer bundles with any combination of wireless telephony/broadband, fixed broadband, fixed telephony, and video services. Both cable operators are investing in expanding their abilities to provide wireless services independently of MNOs. In other words, Comcast and Charter are well placed, and are working to be even better situated, to offer a single "connectivity" source for consumers.

With wireless connectivity, most of the connectivity is actually over wireline (backhaul and the rest of the internet), with only the last portion being wireless. This will become even more accentuated in the 5G world, with small cells and very short wireless connections. Comcast and Charter have dominant positions with respect to the non-wireless portion of the connection and have now added the last piece with their MVNO relationship with Verizon. Investments by the cable operators to expand their abilities to provide wireless services independently of Verizon through a combination of licensed and unlicensed spectrum and the deployment of 5G networks demonstrate that, despite their official MVNO status, Comcast and Charter have and will continue to add significant competition to the provision of wireless telephony/broadband.

The launch of wireless services by cable operators Comcast and Charter, the increasing ability to substitute between wireless and fixed services, and the eventual hybridization of fixed and mobile broadband networks, make it increasingly anachronistic to think that MVNOs—and particularly cable operated hybrid MVNO/MNOs—can be ignored when analyzing competition and price discipline imposed on MNOs in the provision of mobile services.



Michelle P. Connolly

ABOUT THE AUTHOR

Michelle P. Connolly is Professor of the Practice in the Economics Department at Duke University. She was the Economics Director of Duke in New York: Financial Markets and Institutions Program for 2007-2009 and the Director of EcoTeach for several years. She currently serves as the Director of the Honors Program in Economics and a member of the Duke Alumni Association Board.

In 2011, Professor Connolly won the Howard D. Johnson Trinity College Teaching Prize and was named among the top five percent of Duke University Undergraduate Instructors in 2009, 2010, 2011 and 2017.

Professor Connolly previously served as Chief Economist of the Federal Communications Commission in 2006-2007 and 2008-2009, and as an Economist for the International Research Function for the Federal Reserve Bank of New York from 1996 to 1997. She graduated Phi Beta Kappa and Summa Cum Laude from Yale University in 1990, and went on to earn her M.A. and M.Phil in economics. Professor Connolly received her Ph.D. in economics from Yale University in 1996.

Professor Connolly's research and teaching focus specifically on international trade, telecommunications policy, media policy, education, growth, and development. She has received funding for her research from the National Science Foundation, the Duke Arts and Sciences Research Council Grants, the Spencer Grant, and the Teagle Grant. Professor Connolly has published in numerous journals, including the American Economic Review, the American Economic Journal: Macroeconomics, the Journal of Development Economics, the Journal of Economic History, the Journal of Economic Growth, the Review of Industrial Organization, and Current Issues in Economics and Finance. In 2011, Professor Connolly testified before Congress and participated in a White House panel on Spectrum Issues. She has been presenting her work at university seminars and international conferences since 1996. Some of her appearances were at the ACLP Advanced Communications 2009 Summit, where she was a panelist and moderator, at the conference on "Wireless Technologies: Enabling Innovation and Economic Growth", where she served as a keynote panelist, and at the Martin H. Crego Lecture in Economics, an all college Lecture at Vassar College. In 2013 Professor Connolly was awarded a National Science Foundation Secure and Trustworthy Cyberspace Grant, "Dollars for Hertz: Making Trustworthy Spectrum Sharing Technically and Economically Viable."

[1] Walter Piecyk, *Does Comcast Pose a Legitimate Threat to Wireless?,* BTIG (Feb. 12, 2018), http://www.btigresearch.com/2018/02/12/does-comcast-pose-a-legitimate-threat-to-wireless-2/.

[2] Thomas Hazlett noted in 2006, "Rivalrous platforms have arisen to encroach on markets served by incumbent carriers, outside in. Wireless telephony, with over 175 million American subscribers, is moving ever closer to fixed-line service in product space with the added advantage of mobility. Cable TV systems provide a nationwide network parallel to that provided by local exchange carriers. In the wake of deregulation, one half of households can subscribe to POTS via the local cable operator, and virtually any household can use VoIP—without a 'phone company'—by subscribing to cable modem service, where telephony is simply an application riding on broadband networks." Thomas W. Hazlett, *Rivalrous Telecommunications Networks With and Without Mandatory Sharing*, 58 Fed. Commc'ns. L.J. 478, 508 (2006). For a general discussion, *see id.*

[3] *See* Stephen J. Blumberg and Julian V. Luke, *Wireless Substitution: Early Release of Estimates from the National Health Interview Survey, July–December 2016*, National Center for Health Statistics, CDC (May 2017), https://www.cdc.gov/nchs/data/nhis/earlyrelease/wireless201705.pdf.

[4] *See* Nathan McAlone, *Get Ready for Traditional TV to Have Historically Brutal Subscriber Losses this Quarter*, BUSINESS INSIDER (June 6, 2017), http://www.businessinsider.com/cable-tv-subscriber-losses-q2-chart-2017-6.

[5] *See Then & Now: Pay TV Competition*, NCTA, https://www.ncta.com/chart/then-now-pay-tv-competition (last accessed Sept. 7, 2018).

[6] For example, retransmission consent fees have risen from approximately $215 million in 2006 to approximately $7.9 billion in 2016. *See Kagan Releases Updated Retransmission Projections: U.S. TV Station Owners Retransmission Fees expected to Reach Nearly $12.8B by 2023*, PR Newswire (June 19, 2017), https://www.prnewswire.com/news-releases/kagan-releases-updated-retransmission-projections-300475948.html.

[7] For example, lower income households have a higher tendency to connect to the internet using mobile telephony/broadband *exclusively. See* John B. Horrigan and Maeve Duggan, *Home Broadband 2015: The Share of Americans with Broadband at Home Has Plateaued, and More Rely on their Smartphones for Online Access*, Pew Research Center (Dec. 21, 2015), http://www.pewinternet.org/2015/12/21/2015/Home-Broadband-2015/.

[8] The OECD reports that the United States had 81.8 million fixed broadband subscribers, as of the second quarter of 2010. By the second quarter of 2017, there were 108.7 million. This is an almost 33% increase over seven years, with an annual growth rate of 4.7%. *See Fixed Broadband Subscriptions*, OECD, *available at* https://data.oecd.org/broadband/fixed-broadband-subscriptions.htm (last visited July 7, 2018). According to Strategy Analytics, there were 300.5 million cellular subscriptions in 2010. By 2017, there were 374.6 million cellular subscriptions in the United States. This represents a total growth rate of almost 25% over these seven years, for an annual growth rate of 3.5%.

[9] Pew Research Center, *Internet/Broadband Fact Sheet* (Feb. 5, 2018), http://www.pewinternet.org/fact-sheet/internet-broadband/.

[10] Walter Piecyk, *Initiate Coverage of Ruckus Wireless with Buy Rating and $13 Target Ahead of Increased Operator Spending*, BTIG (Feb. 26, 2016), http://www.btigresearch.com/2016/02/26/rkus-buy-13-pt-initiate-coverage-of-ruckus-wireless-with-buy-rating-and-13-target-ahead-of-increased-operator-spending/.

[11] *See Inquiry Concerning Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion,* 2018 Broadband Deployment Report, 33 FCC Rcd 1660 ¶ 18 (2018).

[12] *See Internet/Broadband Fact Sheet.*

[13] The Free State Foundation submitted comments to the FCC arguing that the FCC should recognize "that wireless is a substitute or potential close substitute for wireline." *See* Comments of the Free State Foundation, WT Docket No. 18-203, at 15 (filed July 26, 2018).

[14] *Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993, Annual Report and Analysis of Competitive Market Conditions with Respect to Mobile Wireless, Including Commercial Mobile Services,* Fourteenth Report, 25 FCC Rcd 11407 ¶ 32 (*"Fourteenth Mobile Wireless Report"*) (2010).

[15] *Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993, Annual Report and Analysis of Competitive Market Conditions with Respect to Mobile Wireless, Including Commercial Mobile Services*, Twentieth Report, 32 FCC Rcd 8968 ¶ 93 (2017) ("*Twentieth Mobile Report*").

[16] *Id.* at n.99.

[17] Declaration of John C. Saw Chief Technology Officer, Sprint Corporation, Appendix E, Description of the Transaction, Public Interest Statement, and Related Declarations, WT Docket No. 18-197, ¶ 14 (June 18, 2018).

[18] *Fourteenth Mobile Wireless Report* ¶ 32.

[19] Some MVNOs also provide integrated communications services. Feldman (2002) states: "In some markets, VOs [virtual operators] are intermediaries that offer integrated communication services. In addition to mobile access services, they provide bundles consisting of cable, fixed-line and mobile access." Valerie Feldmann, *Competitive Strategy for Media Companies in the Mobile Internet*, 54 Schmalenbach Bus. Rev. 351, 368 (2002).

[20] *See* Mark L. Burton *et al., Resale and the Growth of Competition in Wireless Telephony*, Expanding Competition in Regulated Industries 117 (2000); Aniruddha Banerjee and Christian M. Dippon, *Voluntary Relationships Among Mobile Network Operators and Mobile Virtual Network Operators: An Economic Explanation*, 21 Info. Econ. and Policy 1 (2009).

[21] *Resale and the Growth of Competition in Wireless Telephony* at 119.

[22] *See id.; see also* Jean Tirole, The Theory of Industrial Organization (1988).

[23] *Resale and the Growth of Competition in Wireless Telephony* at 127-28.

[24] *See Voluntary Relationships Among Mobile Network Operators and Mobile Virtual Network Operators: An Economic Explanation* at 4.

[25] *See id.*

[26] It is also worth noting that if T-Mobile and Sprint merge, the post-merger MNO will be able to offer better national coverage to MVNOs. This implies that the merger should increase—rather than decrease—competition between MNOs *seeking to sell wholesale to MVNOs.*

[27] *See* T. Randolph Beard *et al., The Role of Resale Entry in Promoting Local Exchange Competition,* 22 Telecomms. Policy 315 *(1998); Resale and the Growth of Competition in Wireless Telephony at 131-32.* In addition, firms at an adjacent stage of vertical production are more likely to become potential entrant than an entrant from outside the industry. *Id.*

[28] *Resale and the Growth of Competition in Wireless Telephony* at 132.

[29] *See* The Theory of Industrial Organization at 309, 393 (discussing the pro-competitive effects of the threat of entry).

[30] Burton, Kaserman and Mayo (2000) underscore that, "[T]he theoretical conclusion that resale can serve as a vehicle for upstream entry also does not suggest that resellers that choose to confine their operations to the downstream stage – i.e., they do not opt to vertically integrate -- fail to exert the other beneficial competitive impacts described earlier. In other words, it is not necessary for resellers to integrate backward in order to enhance competition in the affected market or markets. Non-integrated resale can have substantial pro-competitive effects." *Resale and the Growth of Competition in Wireless Telephony* at 133.

[31] Burton, Kaserman and Mayo (2000) explain: "The relative growth in reseller revenues underscores the importance of these providers in the evolution of the interexchange market. While IXC [interexchange carrier] revenues increased by just under 40 percent during the 1992-1997 period, reseller revenues increased by nearly 520 percent so that, by the end of 1997, reseller revenues exceeded 9 percent of industry totals." *See Resale and the Growth of Competition in Wireless Telephony* at 137.

[32] *See The Largest Mobile Network Operators In The World*, WorldAtlas, www.worldatlas.com/articles/the-largest-mobile-network-operators-in-the-world.html (last accessed July 19, 2018).

[33] IBISWorld Industry Report 51791a, *Telecommunications Resellers in the US* at 24 (Dec. 2017); Phil Kendall, *US Wireless Market Outlook and Forecast 2018-2023*, Strategy Analytics (May 2018), https://www.strategyanalytics.com/access-services/service-providers/service-providers-strategies/market-data/report-detail/us-wireless-market-outlook-and-forecast-2018-2023.

[34] *See* Coverage Map, TracFone (last accessed Sept. 7, 2018), https://www.tracfone.com/coverage/check.

[35] MVNOs comprised 9.6% of total US retail wireless subscriptions and 38% of prepaid subscriptions in 2017. *See US Wireless Market Outlook and Forecast 2018-2023*, Sheets 5 and 7.

[36] *See* FCC *Twentieth Report* ¶ 38; Morgan Stanley Research argues that a recent increase in new postpaid subscriptions has come in part from customer transitions from prepaid to postpaid plans: "In 1Q18 for example, the big four added 626k postpaid phone customers, more than 3x the adds in the prior year, despite factoring in 197k wireless adds gained by Comcast. We see a few factors driving this, most notably the strong economy which is increasing multiple device adoption and driving more eligible customers from prepaid to postpaid plans." Morgan Stanley Research, *5 Days and 5 Questions – Question #2: Will we see a return to wireless service revenue growth?*, at 2-3 (July 17, 2018).

[37] GSM Association, *Network Slicing Use Case Requirements*, at 11(April 2018), https://www.gsma.com/futurenetworks/wp-content/uploads/2018/07/Network-Slicing-Use-Case-Requirements-fixed.pdf.

[38] Cisco predicts that more than 63% of total internet protocol (IP) traffic will come from wireless and mobile devices by 2021. *See* Cisco, *Cisco Visual Networking Index: Forecast and Methodology*, *2016-2021*, at 2 (last updated Sep. 15, 2017), https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/complete-white-paper-c11-481360.html.

[39] *See* IBISWorld, *Telecommunications Resellers in the US,* at 9 (Dec. 2017).

[40] *See Charter Reportedly Set to Launch $45-Per-Month Unlimited Wireless Service*, FierceWireless (June 5, 2018), https://www.fiercewireless.com/wireless/charter-reportedly-set-to-launch-5-per-mont-unlimited-wireless-service.

[41] *See* Morgan Stanley Research, *5 Days and 5 Questions – Question #2: Will We See a Return to Wireless Service Revenue Growth?,* at 2-3 (July 17, 2018).

[42] *Initiate Coverage of Ruckus Wireless with Buy Rating and $13 Target Ahead of Increased Operator Spending.*

[43] It is worth noting that cable operators already provide backhaul services to wireless operators.

[44] Charter Communications purchased Time Warner Cable and Bright House Networks in 2016. *See* Brian Stelter, *Bye, Bye Time Warner Cable. Hello Charter,* CNN (May 18, 2016), https://money.cnn.com/2016/05/18/media/time-warner-cable-charter/index.html.

[45] *See* Mike Dano, *Editor's Corner—Charter's Spectrum Mobile MVNO Almost a Mirror Image of Xfinity Mobile, with Slightly Higher Prices and Fewer Options,* FierceWireless (July 3, 2018), https://www.fiercewireless.com/wireless/editor-s-corner-charter-s-spectrum-mobile-mvno-almost-a-mirror-image-xfinity-mobile.

[46] Introducing Xfinity Mobile, Comcast Corporation, https://www.xfinity.com/learn/mobile-service (last accessed Aug. 19, 2018); *see also* Press Release, Comcast Corporation, *Comcast Introduces Xfinity Mobile: Combining America's Largest, Most Reliable 4G LTE Network and the Largest Wi-Fi Network* (Apr. 6, 2017), https://corporate.comcast.com/news-information/news-feed/comcast-xfinity-mobile.

[47] *See* Mike Dano, *Comcast's Xfinity Mobile Begins to Accelerate, but Analysts Remain Wary,* FierceWireless (July 26, 2018), https://www.fiercewireless.com/wireless/comcast-s-xfinity-mobile-begins-to-accelerate.

[48] *See* Diana Goovaerts, *Comcast Wireless Sub Growth Outpaces Rivals*, Mobile World Live (July 26, 2018), https://www.mobileworldlive.com/featured-content/top-three/comcast-wireless-sub-growth-outpaces-rivals/.

[49] *See id.*

[50] *See* Get Access to Free Spectrum WiFi Hotspots in Your State, Charter Communications, https://www.spectrum.com/free-wifi-hotspots.html (last visited Aug. 15, 2018).

[51] *See Cable WiFi Internet Access is Brought to Consumers Through a Collaboration Among U.S. Internet Service Providers,* Charter Communications https://www.spectrum.com/content/spectrum/residential/microsites/cablewifi/cablewifi.html (last visited Aug. 15, 2018).

[52] "The companies . . . have agreed to explore working together in a number of potential operational areas in the wireless space, including: creating common operating platforms; technical standards development and harmonization; device forward and reverse logistics; and emerging wireless technology platforms. The efficiencies created are expected to provide more choice, innovative products and competitive prices for customers in each of their respective footprints. Additionally, the companies have agreed to work only together with respect to national mobile network operators, through potential commercial arrangements, including MVNOs and other material transactions in the wireless industry, for a period of one year." Press Release, Comcast Corporation, *Comcast and Charter to Explore Operational Efficiencies to Speed Entry into Wireless Market* (May 8, 2017), https://corporate.comcast.com/news-information/news-feed/comcast-charter-wireless-efficiencies.

[53] "When marketing the Wi-Fi hotspots, some MVPDs note the potential savings on mobile wireless bills from reduced roaming and usage minutes. A consortium, called Cable Wi-Fi, comprised of Bright House, Cox, Cablevision, Time Warner Cable, and Comcast, allows a subscriber of any of these cable MVPDs to access the hotspots of the other consortium members." *Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming*, Eighteenth Report, 32 FCC Rcd 568 ¶ 61 (2017) (quoting SNL Kagan, Cable TV Investors at 13 (Jan. 29, 2014)) ("*Eighteenth Video Competition Report*"). According to BTIG Research, the Cable Wi-Fi consortium had an estimated 500,000 public hotspots in 2016: "We estimate it would cost less than $250 million to double the coverage of the Wi-Fi consortium's outdoor locations, while still leveraging their existing miles of fiber and coax for backhaul and site locations. That is a small investment for cable operators that spend billions on capex each year and now face a new competitive threat from the wireless industry . . . ." *See Initiate Coverage of Ruckus Wireless with Buy Rating and $13 Target Ahead of Increased Operator Spending.*

[54] *Comcast, Charter Announce Wireless Partnership,* Reuters (May 8, 2017), https://www.reuters.com/article/us-charter-commns-comcast-partnership/comcast-charter-announce-wireless-partnership-idUSKBN1841AQ.

[55] *Charter Communications (CHTR) Q2 2017 Results,* Seeking Alpha (July 27, 2017), https://seekingalpha.com/article/4091430-charter-communications-chtr-q2-2017-results-earnings-call-transcript.

[56] Press Release, Comcast Corporation, *Comcast and Charter Announce Mobile Operative Platform Partnership* (Apr. 20, 2018), https://corporate.comcast.com/press/releases/comcast-and-charter-announce-mobile-operating-platform-partnership.

[57] Mike Dano, *Analyst: Cable MVNOs to Steal 50% of All Wireless Customer Additions by 2020,* FierceWireless (June 27, 2018), https://www.fiercewireless.com/wireless/analyst-cable-mvnos-to-steal-50-all-wireless-customer-additions-by-2020.

[58] Mike Dano, *Editor's Corner—Sprint's MVNO for Altice Doesn't Fill the T-Mobile Merger Void,* FierceWireless (Nov. 6, 2017), https://www.fiercewireless.com/wireless/editor-s-corner-sprint-s-mvno-for-altice-doesn-t-fill-t-mobile-merger-void.

[59] Mike Dano, *Altice: We Won't Lose Money on Mobile*, FierceWireless (Aug. 6, 2018), https://www.fiercewireless.com/wireless/altice-we-won-t-lose-money-mobile (emphasis added).

[60] Similarly, Ericsson's 2016 Mobility Report states that video accounted for approximately half of all mobile traffic in 2016 and estimates that it will increase to around three-quarters of all mobile traffic by 2022. *See* LS telcom AG, *When Will Exponential Mobile Growth Stop?* (Oct. 9, 2017), https://tinyurl.com/yd2ychwu.

[61] Ofcom, *The consumer mobile experience: Measuring the consumer experience of using Android mobile services* (May 9, 2018), at 1.

[62] *Visual Networking Index: Forecast and Methodology, 2016-2021.*

[63] *See* Press Release, Comcast Corporation, *Comcast and Netflix Expand Partnership Following Successful Xfinity X1 Integration* (Apr. 6, 2017), https://corporate.comcast.com/news-information/news-feed/comcast-xfinity-mobile *(citing* NPD Group, *Smartphone Data Consumption Report* (Oct. 2016)).

[64] Data usage was defined as a data download of at least 150KB or an upload of at least 100KB over a data network, whether cellular or Wi-Fi. *See* Nielsen, *What Drives Data Usage?* (Nov. 22, 2016), http://www.nielsen.com/us/en/insights/news/2016/what-drives-data-usage.html.

[65] *Initiate Coverage of Ruckus Wireless with Buy Rating and $13 Target Ahead of Increased Operator Spending.*

[66] Harold Furchtgott-Roth, *WiFi Helps Define the Relevant Market for Wireless Services* (forthcoming 2018).

[67] What Are Xfinity WiFi Hotspots and How Do I Connect?, Comcast Corporation https://www.xfinity.com/mobile/support/article/221762167/what-are-xfinity-wifi-hotspots-and-how-do-i-connect (last accessed Aug. 19, 2018).

[68] Walter Piecyk, *Will Comcast Use Its Fiber for A New Wireless Network?*, BTIG, at 1 (Jan. 3, 2017), http://www.btigresearch.com/2017/01/03/will-comcast-use-its-fiber-for-a-new-wireless-network/.

[69] Walter Piecyk, *Comcast's Wireless Cash EBITDA Losses Up To $1.2 Billion as Sub Growth Stalls,* BTIG (July 26, 2018), http://www.btigresearch.com/2018/07/26/comcasts-wireless-cash-ebitda-losses-up-to-1-2-billion-as-sub-growth-stalls/.

[70] *Id.*

[71] *See Initiate Coverage of Ruckus Wireless with Buy Rating and $13 Target Ahead of Increased Operator Spending.*

[72] *The Race to 5G: Exploring Spectrum Needs to Maintain U.S. Global Leadership Before the S. Comm. on Commerce, Science, and Transportation,* 115th Cong. 3 (2018) (statement of Craig Cowden, Senior Vice President of Wireless Technology, Charter).

[73] Charter Communications News, *Charter Announces First Quarter 2018 Results* (Apr. 27, 2018), http://ir.charter.com/phoenix.zhtml?c=112298&p=irol-newsArticle&ID=2345269. Altice has approximately five million customers. *See* Altice USA, Inc., 2018Q2 Form 10-Q, at 34 (Aug. 9, 2018).

[74] Press Release, Comcast Corporation, *Comcast Reports 2nd Quarter 2018 Results* (July 26, 2018), https://www.cmcsa.com/news-releases/news-release-details/comcast-reports-2nd-quarter-2018-results.

[75] *Eighteenth Video Competition Report* ¶ 52 (quoting SNL Kagan, Cable TV Investors at 14 (Mar. 29, 2016)).

[76] *See* Jeffrey Prince and Shane Greenstein *Does Service Bundling Reduce Churn?* 23 J. of Econ. & Mgmt. Strategy 839 (2014).

[77] The FCC explains that "[i]n response to competition from OVDs [Online Video Distributors], slow growth in household incomes, and higher programming costs, MVPDs have begun offering 'skinny' video packages, which include a limited selection of channels with add-on options revolving around specific subscriber interests such as sports, children's entertainment, or movies." *Eighteenth Video Competition Report* ¶ 53. "MVPDs have also extended the availability of some of their programming to online video platforms, similar to those offered by OVDs, referred to as 'TV Everywhere,' services, which allow MVPD subscribers to access programming on Internet-connected devices. In addition, some MVPDs have begun offering online video services that do not require a subscription to a traditional MVPD service (e.g., DISH Network's Sling TV, Verizon's Go90, and AT&T's DIRECTV NOW)." *Id.* ¶ 4.

[78] *See Voluntary Relationships Among Mobile Network Operators and Mobile Virtual Network Operators: An Economic Explanation* at 15. When an MVNO "imaginatively" bundles mobile services with other services, "it can create an important degree of product differentiation (to service narrower customer niches) that an ordinary reseller cannot." *Id.* at 16.

[79] In 2016, Charter Communications purchased Time Warner Cable and Bright House Networks (which had held spectrum licenses as part of SpectrumCo until 2011). *See Bye, Bye Time Warner Cable. Hello Charter.*

[80] It may take some time for all 600 MHz markets to be cleared and for Comcast to deploy. Still, T-Mobile has already deployed 600 MHz in over 900 markets, and by the end of 2018, plans to have deployed in approximately 10,000 sites.

[81] *See Editor's Corner—Charter's Spectrum Mobile MVNO Almost a Mirror Image of Xfinity Mobile, with Slightly Higher Prices and Fewer Options.*

[82] Mike Dano, *Charter Hints at 25 Mbps Fixed Wireless Speeds using 3.5 GHz in Rural Areas,* FierceWireless (Jan. 31, 2018), https://www.fiercewireless.com/wireless/charter-hints-at-25-mbps-fixed-wireless-speeds-using-3-5-ghz-rural-areas.

83 *See Editor's Corner—Charter's Spectrum Mobile MVNO Almost a Mirror Image of Xfinity Mobile, with Slightly Higher Prices and Fewer Options.*

[84] *Charter Communications (CHTR) CEO Thomas Rutledge on Q4 2017 Results,* Seeking Alpha (Feb. 2, 2018), https://seekingalpha.com/article/4142790-charter-communications-chtr-ceo-thomas-rutledge-q4-2017-results-earnings-call-transcript?part=single.

[85] Reply Comments of Charter Communications, Inc., GN Docket No. 17-258, at 2-4 (filed Jan. 29, 2018).

[86] Letter from Elizabeth Andrion, Senior Vice President, Regulatory Affairs, Charter Communications, Inc., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-258 (filed Mar. 1, 2018).

[87] *See* Monica Alleven, *Charter Wants to Conduct 28 GHz 5G Experiments in Florida,* FierceWireless (Apr. 5, 2017), https://www.fiercewireless.com/wireless/charter-wants-to-conduct-28-ghz-5g-experiments-florida; Dan Jones, *Charter: To Live & 5(G) in LA*, Light Reading (Apr. 5, 2018), https://www.lightreading.com/mobile/5g/charter-to-live-and-5(g)-in-la/d/d-id/742019; *see also* Description of Research Project, FCC Form 442, ELS File No. 0180EX-CN-2017 (granted May 11, 2017).

[88] Zero-Rating services and exclusive content agreements are examples of bundling of content and connectivity services and also demonstrate one dimension in which connectivity providers can differentiate their services from competitors.